

C.E. LANE POOLE MEMORIAL TRUST

LANE POOLE AWARD
STUDY TOUR, 1991/92



A REPORT TO THE TRUSTEES

by

G MAIR



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LANE POOLE AWARD STUDY TOUR REPORT - G MAIR 1991/92

The Lane Poole Memorial Trust was established to commemorate the work of Charles Edward Lane Poole, and in particular, the connection between the former Conservator of Forests and the late Thomas Cullity. The Trust provides financial assistance to officers of the Department of Conservation and Land Management to participate in courses of study that are relevant to their employment. Since 1981, thirteen CALM staff have received these awards.

Enclosed is a report to the Trustees by Greg Mair, relating to his study tour in 1991, which covered aspects of fire management for exotic plantations in South Australia, Victoria, New South Wales and Tasmania.

The Trustees would like to see as many of CALM's staff as possible read these reports and would appreciate you circulating the report to any of your staff who may be interested. Further copies of this report and earlier reports are available from the Secretary of the Trust at Crawley.

Syd Shea
CHAIRMAN OF TRUSTEES

7 September 1994

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C.E. Lane Poole Memorial Trust

The Lane Poole Memorial Trust was established to commemorate the work of Charles Edward Lane Poole, and, in particular, the connection between the former Conservator of Forests and the late Thomas Cullity.

Lane Poole was appointed Inspector-General of the Woods and Forests Department in Western Australia in 1916, and was responsible for establishing the legal framework on which the State's forestry operations have since been carried out.

That legal framework was the 1918 Forests Act. Before the Act was introduced there was no legislation to control the amount of timber cut, the place and manner of cutting, or to regenerate the forest after cutting.

Lane Poole and Professor Tomlinson, the first Professor of Engineering at the University of Western Australia were friends, and Lane Poole pointed out to Tomlinson in 1917 that the Americans had developed a new concept for the accelerated drying of timber - the origins of modern kiln drying. America had entered the war and they had a shortage of dry black walnut for the manufacture of rifle butts. Tiemann in Mid West USA had developed the idea of blowing hot air through timber stacked in a chamber and Lane Poole suggested that this would be a good project for a final year engineering student. Tomlinson agreed, an experimental kiln was built on the Crawley Campus at the back of Shenton House and Thomas Cullity, a final year engineering student, agreed to operate the kiln and detail his experiments in a final year thesis.

When Cullity graduated from the University of Western Australia in 1918, Lane Poole offered him the newly created position of Utilisation Officer in the Forests Department, which he held for one year before leaving to start up Millars' new commercial kilns at Yarloop.

Thomas Cullity maintained an interest in forestry and timber for the rest of his life and founded Cullity Timbers in 1928 and Westralian Plywoods in 1943. From these companies WESFI was formed.

The Trust was initiated by Conservator of Forests Bruce Beggs and WESFI Chairman Denis Cullity in 1981, and was developed by a Board of Trustees representing the former Forests Department and WESFI.

The current Chairman of the Board is the Executive Director of the Department of Conservation and Land Management, Dr Syd Shea.

The WESFI connection resulted from a belief held by Lane Poole that forestry needed an interdisciplinary approach to cater for the needs of society.

The Trust provides financial assistance to officers of the Department of Conservation and Land Management to participate in courses of study that are relevant to their employment. The Award, which covers the cost of travel, tuition and accommodation enables the recipient to study anywhere in Australia and New Zealand for up to six weeks, depending on the project.

WINNERS OF THE C.E. LANE POOLE AWARD

1983	Paul Marsh, Ray Fremlin
1984	Graeme Hutchinson
1986	Gerard van Didden, Tony Brandis
1987	Peter Keppel
1989	Greg Voigt
1990	André Rynasewycz
1991	Greg Mair
1992	Mervyn Smith, Derek Winters
1993	Alan Hordacre
1994	Michael Cully

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INTRODUCTION

Western Australia presently (1990) has approximately 70 000 hectares of State owned softwood and 6 000 hectares of hardwood sharefarm plantation with proposals to greatly increase this area. Many issues arise when undertaking a project of such magnitude but fire management of the plantations from the first planning steps to the final harvest is of paramount importance.

Having being seconded to the CALM Sharefarm Project team for six months I became directly involved in many of the issues relating to plantation management particularly on non-CALM land and where other organisations were involved. I was aware that considerably more extensive areas of plantation existed in the Eastern States, much of it privately owned, and that several States had experienced major fires within and adjoining the plantation.

With this background I anticipated that Lane Poole Award study tour would allow me to examine such issues as inter-agency liaison and agreements, training and allocation of resources, resource sharing, fuel modification in plantations, regional plantation planning and timing of silvicultural operations. During the study tour I inspected the major exotic plantation areas of South Australia, Victoria, New South Wales and Tasmania. While the greater emphasis was on softwood species the opportunity was also taken to examine hardwood plantation areas where possible.

Itinerary

South Australia	7-9 November 1991
Victoria	10-19 November 1991
New South Wales	20 November - 3 December 1991
Tasmania	4-14 December 1991

ACKNOWLEDGEMENTS

I would like to express my gratitude to the staff of the organisations, both government and private, who willingly gave up their time to share with me their issues relating to plantation management within their respective organisations.

I am indebted to the Lane Poole Trustees for making possible the opportunity to broaden my outlook on land management and contribute to one's personal development.

I am also grateful to the officers of the Department of Conservation and Land Management (CALM) for their advice and assistance, especially Mr Rick Sneeuwjagt and Mr Chris Muller for their assistance in establishing contacts in the Eastern States.

SOUTH AUSTRALIA

The south east corner of South Australia is the main plantation growing region. An area which spans the Victorian border and bounded roughly by Portland in Victoria and Naracoorte and Millicent in South Australia demarcate an area known locally as the 'Green Triangle' due to extensive plantations. Mt Gambier forms the hub of this area and is the site of a number of timber processing facilities.

In addition to a number of small growers three main organisations are responsible for plantation management in the region and the areas under their control provide some insight into the extent of plantations in this corner of South Australia.

Woods and Forests Department of South Australia	60 000ha
SE Afforestation Services - SA Perpetual Forest	21 000ha
CSR - Softwoods	21 000ha

Total	121 000ha

In addition to this 121 000 hectares, is plantation owned by the Victorian Department of Conservation and Environment which falls within the 'Green Triangle'.

Southern Border Fire Coordination Association

The location of plantations in relation to the South Australian and Victorian border poses particular problems when it comes to managing fires which may burn through forested or cleared land of all tenure types and across State borders. There are five bodies in the South Australian and Victorian border area with the legal power to act as combating authority (Country Fire Authority and Department of Conservation and Environment in Victoria, Woods and Forests Department, Country Fire Service and National Parks and Wildlife Service in South Australia.). It is also quite possible for a fire to cover land controlled by up to three combating authorities in South Australia as occurred on Ash Wednesday. The fire organisation within each body and between bodies within each State are generally well developed and covered in part by legislation.

In comparison the formal arrangements between interstate bodies has a recent history and there is ongoing refinement of these arrangements to improve the effectiveness of fire suppression in the border area. The Southern Border Fire Coordinating Association was formed to address the problems associated with fire management in the area and to provide a coordinated approach. The SBFCA was responsible for agreements such as 'Procedures for liaison between fire fighting bodies adjacent to the Victoria and South Australia border'.

The organisations involved with these agreements are:

Victoria

Country Fire Authority (CFA)
Department of Conservation and Environment
Trecorp

South Australia

South Australia Country Fire Service (CSF)
South Australia Woods and Forests Department
South Australia National Parks and Wildlife Service

Both States

SE Afforestation Services - SA Perpetual Forest
CSR - Softwoods

WOODS AND FORESTS DEPARTMENT

The Woods and Forests Department of South Australia manages approximately 70 000 hectares of softwood plantation, the majority (60 000 hectares) of which is in the Mt Gambier area. The Ash Wednesday fires burnt approximately 18 000 hectares of softwood plantation and was the catalyst for a review of procedures with the resulting agreements previously outlined.

There is a general acceptance of softwood plantations in Mt Gambier which is obviously linked to the employment they provide. The town has four sawmills, four timber preservation plants, two particle board mills and two timber lamination plants and there are also seven other timber processing facilities within the region.

Detection and Dispatch

The Woods and Forests Department has nine fire towers available for detection of fires in the Mt Gambier area. These comprise five primary towers and four secondary towers, the manning of which is increased according to the predicted fire hazard. When the predicted fire danger index is very high or greater, detection is supplemented by aircraft.

Trials are currently underway in a joint project with the Country Fire Service to assess the suitability of a fire bombing aircraft.

Communications

Recognised as one of the biggest problems still existing since the Ash Wednesday fires, radio systems between the various government and private organisations in this region are currently not compatible. Steps are being taken to establish a compatible, dedicated (fire) network to facilitate management of fire suppression operations. The Southern Border Fire Control Association has in place a dedicated direct telephone contact between the members of the association and a calling procedure in place in the event of a fire.

Plantation Design and Management

Unlike the situation in Western Australia, local authorities do not set standards for design features or plantations such as firebreak width and intensity or compartment size. As a result the application of pre-suppression measures is quite variable.

Woods and Forests firebreaks along main roads were generally well maintained and a high degree of tractor slashing of grass was observed as opposed to the chemical application generally used in Western Australia.

Some pruning of trees is being practised for fire control purposes, however, it did not appear to be systematic or widespread and an investigation team had been formed to review guidelines and recommend policy changes.

Fire Equipment, Water Supplies

Fire fighting appliances owned by Woods and Forests are similar to those in Western Australia, however, there is a greater emphasis on being able to knock down running fire from a moving truck.

This is due to the flatter, more open country with less reliance on machines to construct a fireline from which to operate. The South Australian equipment is more orientated to plantation and grass fires given that little remains of the original native vegetation.

The use of foam injection systems on fire tankers is common and most units are fitted with heat shields on the rear to protect the crew.

Because of the difficulty in obtaining water the use of supplementary ferry tankers is quite common. Woods and Forests provide 9 000 litre tankers for every two to three suppression units and have arrangements in place for the provision of milk tankers from the dairy industry.

Fuel Reduction Burning

No under pine burning is practised in the South East Region as it is considered too expensive and only minimal areas of native forest are burnt under a seven year rotation.

Training

Integration with the Country Fire Service is fostered at the local level and in training sessions. Most regular departmental firefighters are trained to CFS level I and some to level II or III. The introduction of CFS forest fire suppression training notes, developed with the assistance of Woods and Forests facilities joint training and suppression operations in forest areas. Private forest fires are managed by the CFS but the suppression effort is a joint one involving the CFS, Woods and Forests, CSR and SEAS-SAPFOR.

CSR SOFTWOODS, MT GAMBIER

CSR - Softwoods owned or controls some 21 000 hectares of softwood plantations within the south east of South Australia and south west of Victoria. The company is a party to mutual aid agreements such as the Southern Border Fire Coordinating Association and Forest Owners Conference.

The company provides six fire tankers and three supply tankers (one 27 000 litres) to protect its assets as well as supplying a towerperson for Mt Gambier and a rostered observer for the sponsored surveillance aircraft. Fire crews are employed by the company and undertake plantation maintenance work when not required for fire control.

CSR conducts fire training for its own employees at the CFS level I and II with acceptance at level II being endorsed by the CFS.

Plantation Design and Management

Under current practices, plantations are established at a normal stocking of 1 450 stems per hectare with a compartment size of approximately eight hectares. They are divided by seven metre wide tracks which are low pruned (and the prunings pushed in) if required for truck access. Some low pruning for fire control purposes up to 20 metres in width is practised along strategic locations, eg where northern side of compartment adjoins scrub. High pruning is only currently practised on approximately 50 hectares of high site quality plantations for silviculture benefits not fire control.

Plantation design guidelines have been agreed to by the Forest Growers Conference for implementation in plantings established after 1988. The key points of these guidelines are:

- a) external firebreaks 20 metres wide;
- b) 20 metre firebreaks enclosing areas not to exceed 400 hectares;
- c) vehicle access tracks to enclose compartments not exceeding 25 hectares; and
- d) setbacks from dwellings adjoining the plantation to be:
 - 50-100 metres on the northern and western side of dwellings.
 - 20-50 metres on the eastern and southern side of dwellings.

Prior to the establishment of a chipwood market, a Hydro-Axe was used up every second or third cut row to modify the fuel arrangement and improve fire control access. The chipwood market now utilises much of the previously unsaleable debris. A Hydro-Axe is also used prior to clear fall, primarily to improve access for the harvesting operation but also has fire control benefits.

SEAS-SAPFOR, MT GAMBIER

South East Afforestation Services Pty Ltd and South Australian Perpetual Forest Ltd (SEAS-SAPFOR) is a significant company in the south east of South Australia with almost 41 000 hectares of softwood plantation on both sides of the South Australia and Victoria border. As a member of the Forest Growers Conference and Southern Border Fire Coordination Association the company is involved in the cooperative agreements previously outlined.

SEAS-SAPFOR is still actively planting with an establishment figure of approximately 1 400 hectares per year. The company operates six fire trucks and two supply tankers in the Region and shares tower detection costs with South Australia Woods and Forests. They also contribute to the cost of operating a surveillance aircraft from Mt Gambier when required.

Training is a similar arrangement to CSR where company personnel can direct training which is subsequently endorsed by the CFS. Harvesting for SEAS-SAPFOR is carried out by contractors who for log supply reasons are not involved in fire control until absolutely necessary. Company staff and casuals are used for fire control in preference to contractors.

Plantation Design and Management

Current practice is to establish plantations with 20 metres external firebreaks and compartment size approximately 20 hectares. Efforts are made to keep the maximum distance along rows to greater than 400 metres.

The market for SEAS-SAPFOR products does not include a high percentage of clear wood hence no significant low pruning is performed. Low pruning is confined to small areas around buildings and a 'Topper-Edger' is used in access ways to maintain vertical clearance, mainly for harvesting vehicles.

VICTORIA

In Victoria the Department of Conservation and Environment (DCE) is responsible for managing some eight million hectares of public land, including marine and freshwater environments. The Department has established 16 administrative regions throughout Victoria, four of which, were visited during the study tour. These were Portland, Ballarat, North East and Central Gippsland Regions.

Like all government bodies managing public land, DCE has a statutory responsibility to carry out proper and sufficient work for the prevention of suppression of fire in every State forest, national park and all protected public land. In addition the Department has fire prevention responsibilities on other land within 1.5 kilometres of State forest, national park and protected public land unless such land is excised from those responsibilities.

As part of meeting DCE Fire Management Policy each region prepares a Regional Fire Protection Plan which broadly outlines the main fire issues and strategies, including plantation protection, which are relevant to each region. Priority zones with differing fire management criteria, are identified in much the same way as Wildfire Threat Analysis is used in Western Australia. Broadly these are:

Priority One Zone - These zones provide the highest level of protection of life, property and public land values and assets. The majority of these areas are located to the north and west of, or intermingled with townships, settlements and softwood plantations. Burning is scheduled in this zone to maintain fire greater than eight tonnes per hectare over 90 per cent of the area.

Priority Two Zone - Are located so as to provide substantial barriers to the progress of wildfires. When combined with priority one areas it will form continuous belts of public land with fuel levels greater than 12 tonnes per hectare over 80 per cent of the zone.

Priority Three Zone - Areas of land where fuel reduction burning is carried out to reduce the destructiveness and suppression difficulty of wildfires and to complement works in higher priority areas. The objective of burning in these areas is to achieve a mosaic of burnt and unburnt country with up to 50 per cent of the planned area burnt in each operation.

Priority Four Zone - These are areas in which burning may be appropriate at times but has the lowest priority with regard to fire protection.

Burning Periods

Victoria, unlike the situation in Western Australia, has no pre-determined periods of restricted or prohibited burning. The organisation responsible for coordinating fire protection on private property and land not under the control of DCE is the Country Fire Authority (CFA). The CFA declares both fire bans and determines the periods for which permits are required according to dryness and fire hazard of the season.

The Victorian DCE operate their own fire ban system according to the hazard calculated and can require burning permits for all 'other land', including private property within 1.5 kilometres of DCE land. In this way some control can be exercised over lighting of fires which may threaten DCE land.

Training

Occupational Health Safety and Welfare legislation was requiring changes to the present fire training system in place within DCE. Training was conducted by qualified presenters within each region and trainees accredited internally. The current levels are as follows:

- a) Basic fire fighters - two day course for all people involved in fire.
- b) Crew leaders - five day course which was a pre-requisite for undertaking further courses and was a core unit for technical staff undertaking Associate Diploma studies.
- c) Fire line supervisor - two day course focusing more on supervising skills and focused at staff performing a Sector Boss type role.
- d) Fire line boss - five day course addressing whole fire management, strategy, tactics, personnel management and fire behaviour predictions.

Communications

The existing communication system makes use of telephone, facsimile, radio and the Department's computer network. Radios on Country Fire Authority frequency are operated in most offices and in selected vehicles of key fire control staff and lookouts throughout the State.

Plantation Fire Protection

The Department of Conservation and Environment has prepared Fire Protection Guidelines for softwood plantations which have recently been updated (1990) and are presently in draft form. The objectives of the guideline are to:

- a) prevent fire from commencing in or entering the plantation;
- b) restrict fire damage to a minimum; and
- c) protect assets on adjacent property from damage by a fire in the plantation.

The guidelines are based on two key fire protection principles:

- provide maximum safe access for fire fighting forces; and
- provide fire protection works and facilities at strategic locations to minimise the area burnt and to maximise the chance of suppression success on intense fires at pre-determined control lines.

Listed in order of priority the measures proposed by DCE to safeguard plantations against fire are:

- a) Location of plantation and access to it.
- b) Perimeter protection measures and perimeter access.
- c) Internal access and water supply.
- d) Internal minor breaks.
- e) Internal major breaks.

The key points of these measures can be summarised as follows:

- a) Location of Plantation and Access to it - a plantation should be located in an area of low fire risk and be reasonably close to suppression forces
- b) Perimeter Protection and Access
 - Fuel Reduction Burning - minimum width of 200 metres with a maximum fuel load of eight tonnes per hectare on up to 90 per cent of the area.
 - Agricultural Treatment - minimum width of 50 metres, eg green cropping or grazing.
 - Stag Removal - fall all stags within 20 metres of boundary.
 - Undergrowth Reduction - removal of scrub undergrowth for minimum width of 20 metres from boundary.
 - Boundary Access - suitable for tankers, no dead ends, signposted, passing points no more than 500 metres apart, gully crossing minimum of five metres.

- Boundary Firebreak - minimum fuel gap 20 metres, ie distance from edge to first plantings and can be reduced to 10 metres on low risk sites mineral earth break three to five metres.
 - Perimeter Pines - trees pruned to three metres to a depth of 20 metres to 50 metres and back up track desirable.
- c) Internal Protection
- Major Break - 100 metres minimum break upwind, 50 metres minimum break downwind of major road or track and incorporating a firebreak of 20 to 40 metres. Plantation upwind and downwind of firebreak to be pruned to a height of three metres. Major breaks to be two to three kilometres apart.
 - Secondary Break - minimum width of 8 to 10 metres width, to tanker standard, maximum 600 to 800 metres apart.
 - Internal Access Track - internal vehicular access tracks, to tanker standard, to within 300 metres of any point in the plantation. Vertical clearance to three to four metres, passing points at 500 metres maximum apart and signposting is also required.
 - Water Supply - water points of at least 100 000 litres to be located 6 to 10 kilometres apart.
 - Airstrip - provide an airstrip with a retardant base facility within approximately 35 kilometres of the plantations.

In practice, the application of the plantation fire protection guidelines in the field is quite variable throughout the regions visited. As with the situation in South Australia, local authorities in Victoria do not stipulate minimum plantation firebreak standards.

Under Pine Burning

In Victoria fuel reduction burning in softwood plantation is a recently accepted technique. Due to the costs, risks involved and number of constraints no significant use of this technique was observed.

PORTLAND REGION

Portland Region of the DCE in the south west of Victoria manages approximately 227 000 hectares of public land which is about 14 per cent of the total area of the region.

The Region has approximately 15 900 hectares of softwood plantations, several of which are in the Rennick and Lower Glenelg area and participants in the interagency agreements with South Australian plantation managers.

Fire History and Causes

Major fires in Portland Region developed in 1966, 1976, 1978, 1979 and 1989. The primary causes of fires in the region over the ten year period 1976/77 to 1985/86 were as follows:

Deliberate lighting	22%
Escape Burning off	18%
Lightning	11%

Detection

The region's detection system is based on a network of six fire lookouts. Lookouts from the adjoining region and South Australia also assist. This system is supplemented by ground and when necessary aerial patrols.

Plantation Management

Access around most plantations in the Portland Region appeared to be of a reasonable quality. The exception to this was the Kentbruck plantation which is a 5 000 hectare block of basically unroaded pine. As products were being extracted the opportunity was being taken to establish a firebreak system on a two to three kilometre grid pattern. A 40 hectare compartment surrounded by a 20 metre firebreak and then subdivided into 2 x 20 hectare cells by a 10 metre break was the standard being applied.

Low pruning was practised on access tracks and high pruning where access remained a problem. Much of this pruning was being focused on northern and western boundaries. Crown fire free zones were to be developed along strategic roads comprising tree pruning to a height of two metres for 80 metres upwind side of the road and 40 metres downwind side. The trees in this zone were to be heavily thinned to reduce the possibility of a crown fire.

Under pine burning is not used in any amount to provide protection from fire, however some burning is done in advance of clear felling to eliminate pine wildlings, which would otherwise persist through the harvesting operation and 2R preparation to become a nuisance. The Hydro-Ax machine is used where burning is not performed prior to clear fall and along extraction rows where grass invasion will not carry fire in prescribed conditions.

BALLARAT REGION

The DCE's Ballarat Region covers 1 151 000 hectares, of which nine per cent is public land. Softwood plantations were first established in the area in 1888, initially to reclaim land mined over during the gold rush of the mid 1800s. There is presently 8 050 hectares of DCE softwood plantation in the region.

The Ballarat Region has a history of infrequent severe fires (about every 10 years) interspersed with frequent small fires. In recent times (1977 and 1985) two severe wildfires, both exceeding 50 000 hectares and claiming human life and stock loss, occurred within the region.

Fire statistics for the five year period 1981/82 to 1985/86 reveal the main causes of fires in the region to be as follows:

Unknown	24%
Deliberate lighting	23%
Cigarette, Match (Disposal)	11%
Lightning	9%
Burning off	6%

Detection

Six fire lookout towers provide detection in the Ballarat Region. Other fire towers on the adjoining regions also view parts of the region and assist in locating fires. Aerial reconnaissance is only used occasionally to supplement the tower system.

Plantation Management

Fuel reduction hand burning of priority one zones adjoining plantations is the primary onground fire protection measure used to protect the plantations. The areas are generally burnt in spring due to the reduced intensity and scorch but as could be expected around a major population centre, environmental conflicts and smoke management are becoming issues. Aircraft burning is not common in the Ballarat Region.

Compartment size in the Ballarat Region plantations is 20 to 40 hectares with firebreaks ranging in width from 5 to 20 metres. As was the case in South Australia and other parts of Victoria, slashing appeared to be the main method of maintaining grass and scrub fuel levels along firebreaks.

Pruning to a depth of three to four rows (six to eight metres) is practised on most external perimeters of plantations especially on the northern and western sides. A crown fire free zone consisting of pruned trees to a height of two metres for 80 metres on the upwind side and 40 metres on the downwind side had been established as a trial but was not widely practised.

While aircraft are not commonly used for detection they play a large part in the suppression effort in Victoria. In Ballarat Region air support facilities exist at seven sites with numerous additional helipad sites identified.

NORTH EAST REGION

The North East Region of the DCE totals 1 855 000 hectares of which 995 000 hectares (54 per cent) is public land. The DCE has approximately 33 000 hectares of plantation in the region.

The region is generally mountainous along the Great Dividing Range and south and east grading through foothills to open plains in the north west. In the south and east there is almost continuous public land, in the north west predominantly private land with small areas of public land but the bulk of the region is characterised by cleared private land in the valleys with forested public land in the mountains and foothills between.

Since the disastrous fires of 1939, which burnt most of the mountainous part of the region, major fires have occurred in 1944, 1952, 1968, 1972, 1978 and 1985.

Fire causes in the ten year period 1978/79 to 1987/88 confirm lightning to be a major fire source.

Lightning	42%
Deliberate lighting	9%
Cigarette/Match	7%
Campfire/Barbecue	6%

Liaison

Close liaison with other emergency services and relevant authorities in the North East Region is essential to plan and coordinate fire pre-suppression activities. The region adjoins the border of New South Wales and liaison is conducted with a number of authorities in that State and within the North East Region.

Detection

The primary means of detecting fire in the region is by a network of fire lookouts supplemented by aerial patrols and ground surveillance. There are eight primary lookouts in the region with three other lookouts used on days of high fire danger.

Plantation Management

Roading intensity and plantation design in the steep areas of the North East Region is very much dictated by the topography. The roading is limited by the slope and an acceptable grade for subsequent harvesting operations. As a result, the roading network is far from that ideal for fire protection being narrow and lacking in turn-arounds.

Protective burning is achieved by carrying out fuel reduction burning of native forests in priority one zones adjacent to plantations. In many cases the boundaries between the two were located on the top of spurs with a break of five to nine metres only, making the fuel reduction burning and fire suppression a difficult operation.

In this region the local authority requires a 20 metre firebreak around private plantations. New DCE plantations on ex-farmland are being roaded to incorporate a 10 metre firebreak every 200 metres.

Minimal pruning at selected locations is carried out to strengthen firebreaks and improve access along internal tracks. No additional (in compartment) pruning or under pine burning is practised.

Age classes and market demand determine the location of harvesting operations. As a result of the DCE demanding higher log prices than some of their competitors, many areas were not being thinned on time and the resultant fire control benefits not being achieved.

AFI, MYRTLEFORD

While in Myrtleford the opportunity was taken to look at the integrated softwood processing plant operated by Australian Forest Industries (AFI). Australian Forest Industries is the major production unit of the Forest Products Division of Bowater Tissue Limited.

The integrated site operation consists of a sawmill, plymill and pulpmill. Production on site commenced in 1974 when the sawmill was commissioned. At the time the sawmill was considered to be the most technically advanced in Australia.

The pulpmill, commissioned in 1974, produces a range of mechanical pulps using the chips from sawmill waste and trees unsuitable for timber production purposes.

The plymill, commissioned in 1981, receives the larger high quality logs from the forests and these are rotary peeled and clipped into veneer sheets.

At the present time the plymill converts 35 000 cubic metres of log into its various products, which makes it the largest single site plymill in Australia.

The site supports employment of approximately 320 persons and contracting companies in logging and transport who depend in most part on the operations, employ a further 150 persons. The industry is the major employer in the Myrtleford Shire and is estimated to directly and indirectly support almost a third of its habitants.

CENTRAL GIPPSLAND REGION

Within the Central Gippsland Region the DCE manages some 850 000 hectares of public land which is 60 per cent of the total land area. The region comprises a wide variety of vegetation types, the most notable being the wet sclerophyll forests, the coastal vegetation, the dry sclerophyll forests of the foothills and the alpine vegetation of the high country with each type presenting a different fire protection problem.

The wet sclerophyll forests, although normally less flammable, are capable of generating fires of cataclysmic proportions (1939, 1983). Fires on the coastal areas are relatively infrequent but have a high potential for loss of life and damage to property (1983). The main fire cause statistics for the ten year period 1978/79 to 1989/90 are as follows:

Lightning	44%
Deliberate	16%
Unknown	7%
Campfire/Barbecue	7%

The region includes the La Trobe Valley, site of three power generating stations, providing most of the electricity for Victoria, and home to almost 100 000 people. In addition to DCE, two other managers, State Electricity Commission and APM Forests hold a significant land base in the area (20 000 hectares and 80 000 hectares respectively).

Of the 850 000 DCE manages in the region approximately 5 000 hectares is planted to softwood plantation with the majority being in the western end of the region.

Liaison

As previously discussed there is a great need for good liaison within the Central Gippsland Region. A number of other organisations manage large tracts of land in the area and have high value assets requiring protection from fire which recognises no tenure or ownership boundaries. Regular consultation is required with relevant organisations such as:

State Electricity Commission (SEC)
Country Fire Authority (CFA)
Australian Paper Manufacturers (APM) Forests
La Trobe Valley Water and Sewerage Board (LVWSB)
Melbourne and Metropolitan Board of Works (MMBW)

Detection

During the periods of fire danger, detection of fires is primarily from a network of six fire towers owned and operated by DCE. Lookouts controlled by other regions are used to supplement the network. Aircraft are used on days of high fire danger and following lightning storms. In addition, APM Forests own and operate three fire towers and the SEC three within the region.

Plantation Management

While detection and rapid response plays a key part in providing protection to plantations in Central Gippsland, fuel reduction of native forests by burning contributes on the broader scale. Most burning is conducted in autumn due to risk of re-ignition during the summer if burnt in spring, manpower availability and the community environmental concerns raised about effect of spring burning on flora and fauna.

Under pine burning is not widely used, but an example was observed in Moondarra plantation of mild edge burning to reduce ground fuels. To some extent this was carried out due to an inability to burn the adjoining native forest because of environmentalist pressures. Rapid growth of sedge and ti-tree species in some areas quickly negated the effect of the under pine burning.

Fuel modification techniques such as pruning or mulching was not being practised in Central Gippsland by DCE as most of the plantations were relatively young.

APM FORESTS LA TROBE VALLEY

Within the La Trobe Valley Australian Paper Manufacturers (APM) Forests is both a significant employer and landholder.

Approximately 1 450 people are employed either directly or indirectly in the operations of their processing plant, which utilises 200 000 cubic metres sawlog and 1.24 million cubic metres chiplog per year, or management of plantations. A total of 80 000 hectares of freehold and leasehold land is managed by APM, on which is planted 42 000 hectares of pine and 8 000 hectares of eucalypt plantation.

Training

Fire training is conducted by APM staff to employees in the subjects of fire behaviour, safety and equipment, culminating in an annual fire competition. Role training is conducted for the fire management tasks such as controller, fire boss, sector boss and aerial observers. Harvesting contractors are not used on fire suppression until the last resort.

Detection

Fire detection of the companies assets is provided by three fire lookout towers owned and operated by APM. In addition APM have an agreement with the local aero club to provide an aircraft for surveillance when necessary. During the summer period APM lease a helicopter for rapid response to fire reports.

Plantation Management

A company standard of 20 metres external firebreaks and roading at 400 metre intervals is employed in APM plantations. The roading intensity is dictated more by access required for harvesting than fire control. A chopper-roller is used to manage harvesting debris in second rotation stands, in preference to fire due to the potential nutrient loss in the combustion process.

NEW SOUTH WALES

In New South Wales the Forestry Commission manages 3.8 million hectares of State forests and timber reserves for multiple use. Included in this figure is about 175 000 hectares of softwood plantation, located primarily in the Albury, Bathurst and Eden Regions.

Under the Bush Fires Act a statutory Bush Fires Danger Period applies in New South Wales from 1 October to 31 March but can be varied by local government. In addition, the Act gives the Forestry Commission legal powers to manage fires within eight kilometres of State forests and timber reserves. During the Bush Fires Danger Period a Plantation Fire Threat Period is invoked by each district according to the fire hazard.

Fuel reduction burning of native forests, including those adjoining plantations, provide much of the protection from the inevitable summer bushfires.

ALBURY REGION

The Tumut, Batlow and Tumbarumba Districts of the New South Wales Forestry Commission form part of the Albury Region and combine to make up a geographical unit of approximately 1.2 million hectares. The districts are located on the south west slopes of the Great Dividing Range with common borders to Victoria and the Australia Capital Territory.

Softwood plantation establishment commenced in the Tumut area in 1921, continuing until 1935 when the Government suspended planting to review its viability, not resuming until after World War II in the late 1940s. Planting increased dramatically in 1966 to 1972 as a result of New South Wales' participation in the Commonwealth Softwood Forestry Agreement Scheme. During this period native forest was 'converted' to pine plantation until opposition to this gained momentum.

Acquisition of agricultural land for plantations in the late 1970s allowed for a change of emphasis from native forest conversion in line with government policy. The region now has approximately 80 000 hectares of the Forestry Commission's total holding of 175 000 hectares of softwood plantation, and approximately 20 000 hectares of private plantation.

The main causes of fire in the area for the five year period 1985/86 to 1989/90 are as follows:

Lightning	54%
Machinery	9%
Powerlines	7%

Detection

Detection within this part of the Albury Region is provided by eight fire lookout towers owned and operated by Forestry Commission (six) and National Parks and Wildlife Service (two). Four other towers operated by the Department of Conservation and Environment and Australian Capital Territory Bushfire Council provide some detection and confirmation of bearings.

Aircraft (usually private) are used in situations of very high or extreme fire danger, poor visibility, multiple fires or periods of lightning activity.

Liaison

The geographic location of the region, bordering the State of Victoria, the Australian Capital Territory and adjoining the Kosciusko National Park, requires that a high level of liaison take place with other organisations involved in fire management. For example:

National Parks and Wildlife Service
ACT Bush Fire Council
Various Shires
Snowy Mountain Authority
Department of Bushfire Services (NSW)
Department of Conservation and Environment (Vic)
Country Fire Authority (Vic)

Informal liaison is ongoing and more formal liaison was made through the Eastern Riverina Bushfire Prevention Scheme and the Western Border Liaison Committee.

Plantation Management

Plantation firebreak width is not legislated by the local authorities in the region, nor do the Forestry Commission appear to have a standard policy. The width of firebreaks tends to be governed by the standard of road, (ie the higher the standard, the wider the break) and by the terrain.

Compartment size varied from approximately 20 hectares, to 100 hectares in the older plantations, with the optimum size being considered 20 to 40 hectares.

Low pruning 50 per cent of the trees in plantations was standard practice, with a priority on ex-pasture sites, primarily to achieve higher quality sawlogs but also to improve fire access and to break the continuous floor to crown fuel. Minimal high pruning was carried out alongside major roads for a depth of up to 30 metres in an attempt to provide a fuel reduced buffer.

Under pine burning is not practised in this part of the Albury Region, however fuel reduction burning of adjoining native forests in autumn is carried out for plantation protection.

Meeting the market demand for product was the dominant force in determining the location of harvesting operations, with fire control being a secondary consideration. Thinning was more up to date in plantations closer to the major markets.

BATHURST REGION

Orange, Oberon and Lithgow Districts form Bathurst Region of the New South Wales Forestry Commission, within which there is approximately 61 000 hectares of softwood plantation.

Orange District, situated on the western edge of the Eastern Tablelands, includes the City of Orange (approximately 33 000 people) and has some 12 000 hectares of softwood plantation and 12 000 hectares of native forests.

Major fire causes in Orange District are of the following order:

Accidental	60%
Arson	20%
Lightning	20%

The majority of the arson ignitions are related to the disposal of stolen cars on Forestry Commission land.

Detection

Fire detection in Orange District is provided by three primary and one secondary fire lookout towers. Private aircraft engaged on hire are used during emergency periods to provide aerial surveillance.

Plantation Management

The historical approach to plantation establishment in Orange District was to maximise all available plantable ground and minimise the area lost to firebreaks. Firebreak requirements are neither legislated by local authorities or set in policy by the Commission and tend to be in the range of 10 to 20 metres for external breaks. Compartment size is around 40 hectares with approximately 400 metres from road to road within compartments.

Low pruning, mainly for wood quality but also fire control reasons, is carried out in all stands but with particular emphasis to those on ex-pasture. Outrows are not pruned and only about 50 per cent of stems are pruned on ex-bush sites. The priority for pruning is those sections on the west side of plantations where a greater fire threat exists.

High pruning is presently not practised, however some older plantation has been high pruned.

Approximately 84 per cent of plantations in the area are on purchased farmland, a declining trend due to government finances, and contribute to an annual first rotation planting program of approximately 400 hectares per year.

Canobolas Fire

The Canobolas fire was to become the second most damaging *P.radiata* plantation fire (after Bombala) to date in New South Wales.

Over four days 28th to 31st January 1985 it burnt a total of 9 610 hectares of land comprising:

Canobolas State Forest - <i>P.radiata</i> plantation	2 439 ha
- Native forest & grassland	907 ha
Mt Canobolas Park Trust	130 ha
Private property	6 134 ha

	9 610 ha

Fire weather during the period of the fire was extreme, with winds on day one shifting from north west to south west, and then returning to north west on days two, three and four culminating in gale force winds then light rain on the final day.

Some aspects of the fire:

- The fire started at approximately 0830 hours on private land about five kilometres south of the Canobolas State forest and west of the main plantation area but was not reported to the Commission until 1020 hours when the towers went up for the day. This delay in a rapid, concerted effort by all forces was to be significant in the following days.
- Access around the eastern edge of the fire on day one was not possible due to the rugged nature of the country.
- A south west change, forming an extensive headfire after a north west fire run, created a fire which was essentially uncontrollable.
- Flank attacks in the heavy grass fuels required a mineral earth break to prevent reignition and were slow to construct.
- Aerial water bombing in grass and forest fuels was used with no discernible reduction in fire behaviour.
- Spot fires, some up to three kilometres spotting distance, played a significant part in the fire. An area of retained hardwood was considered to have contributed significantly to 'feeding' the fire into the plantation. Spotting seemed to originate more from native forest than from pines.
- The headfire continued to crown in unthinned, pruned stands under conditions which were quite mild. Other crown fires were associated with topographical runs.
- Backburning at night proceeded slowly due to a strong tendency of the flames to burn the crowns of edge trees even in low pruned stands.
- Comparatively little mop up was required in plantation areas as opposed to native forest.
- The fire intensity was very low for approximately one third of the area burnt within sections of Canobolas 1950 to 1971 age classes. The trees in this area remain alive. A clear pattern of tree deaths in scorched areas and surviving pines in unscorched areas has emerged.

The Canobolas fire prompted a review of roading in the plantation and the adjacent lands, fuel management of native forests and liaison with plantation neighbours.

It is difficult to comprehend a situation where a fire burns out of control in high fire danger conditions within five kilometres of a pine plantation lying up slope from the fire for two hours without advice to, or a request for assistance being made to the Forestry Commission.

NEW SOUTH WALES NORTH COAST

State forests of the north coast of New South Wales, stretch from Wyong to the Queensland border and inland to the edges of the New England Tableland, and include about one million hectares of forest. The area is quite heavily populated and serviced by major roads to population centres along the coast.

A summer maximum rainfall is experienced along the coast with annual average rainfall of 1 500 to 1 700 millimetres, varying with altitude, with the peak of the fire season occurring normally in November or December. This variation in season with the southern and eastern parts of New South Wales provides the Forestry Commission the opportunity to progressively move suppression resources southwards as summer approaches and rain increases along the north coast regions.

The topography in this area ranges from open and undulating country near the coast to steep country inland. Fire suppression is difficult in the steep topography and usually requires the use of handtool fire lines or wet gully systems to act as a firebreak.

Hardwood plantations along the north coast are not 'plantations' in the traditional sense but areas of regenerated native forest, albeit often to a preferred species off its naturally occurring site. Some exceptions to this were observed in Kendall where Blackbutt plantations had been established on ex-farmland. The regeneration is managed in a similar way to regenerated Karri forest in south west of Western Australia.

Common sources of fires were arson and escapes from fires lit by adjoining landowners. Wyong District has historically experienced significant fires about once in every decade. Fuel reduction burning is carried out in the area to provide protection to 'plantations', forest and community values, however planning of a fuel reduction program is difficult due to the seasonal variation experienced. This results in opportunistic burning when a suitable season eventuates and is commonly confined to burning from ridgetop roads and allowing the fire to burn to a moisture differential.

Coffs Harbour District, with a management area of 75 000 hectares was the northernmost point of the study tour. The District has 2 000 hectares of hardwood plantation and 2 000 hectares of softwood plantation (*P.elliottii* and *P.taeda*) on low site quality coastal landforms.

Generally the District does not have a significant fire season due to the high rainfall and hence fuel reduction burning is opportunistic.

A number of wildfires originate along the coastal strip, which does not experience the rainfall of the mountain ranges, as a result of land owners lighting crown land to encourage grazing for stock. These fires have the potential to threaten the pine plantations. Protection of the plantations from fire is provided for by fuel reduction burning of the adjoining native forest cells and fuel reduction burning within the plantations.

P.elliottii and *P.taeda* are less sensitive to fire than *P.radiata* which is more commonly established in plantations, and lend themselves to under pine burning in prescribed conditions without risk of significant damage to timber quality. Approximately 400 hectares of plantation per annum is fuel reduction burnt, resulting in the total plantation being burnt over a five year period.

TASMANIA

The Forestry Commission of Tasmania is responsible for managing State forests and timber reserves, the total area of which represents some 22.5 per cent of the total land mass of Tasmania. About 40 per cent of Tasmania remains dominated by eucalypt vegetation and in round terms one third of the State is national park, one third State forest and one third private property.

Tasmania experiences a relatively mild climate with steep gradients of both rainfall and temperature on mountainous terrain. The south west of Tasmania is more rugged and significantly wetter than the eastern portion of the State. In some years, due to the climate, no fire danger season may be experienced at all but normally it is restricted to a peak of one or two months in the summer.

Neither the Commission or local authorities set standards for fire management of softwood plantations. The Commissions current attitude to firebreaks is that previous policies requiring wide firebreaks utilised valuable plantable areas without demonstrating any fire control benefit.

In managing the 70 000 hectares of plantation under its control the Forestry Commission follows a basic philosophy that a greater risk fire exists from outside the plantations than from within. As a result the primary method of protecting plantations from fire is to carry out fuel reduction burning of adjacent native forests. This is causing problems due to failure (for a number of reasons) to achieve the burning program, risk of escape from the buffers and the presence of debris from commercial operations adjacent to burning buffers.

Fire lookout towers in plantations and aircraft over the forested areas are the primary method of detecting fires, the main causes of which are arson, escape from private property burning and lightning.

FINGAL DISTRICT

The Commission's Fingal District, located on the central east coast of Tasmania manages 12 000 hectares of *P.radiata* plantations, up to 30 years old, located in four main cells. Annual rainfall ranges from 700 to 1 300 millimetres and even higher in some mountain areas.

In Fingal District the Tasmanian Fire Service (similar to Western Australia's Bush Fires Board) declares a fire season, for which permits to burn are issued by a shire or brigade officer, from December to March.

Detection

Detection of fires in Fingal District is provided by three fire towers, manned by casually employed local people, and supplemented by hire of aircraft when significant fire weather exists or surveillance over a wildfire is required.

Plantation Management

In the absence of firm Commission requirements each District appears to have developed a slightly different philosophy on plantation fire management according to their perceived risk, financial and topographical constraints.

Low and high pruning is not practised as standard practice in Commission plantations, but some higher site quality stands receive this treatment. Limited side pruning is performed along roadsides and firebreaks to maintain vertical clearance.

APPM FORESTS, BURNIE

Associated Forest Holdings trading as Australian Pulp and Paper Manufacturers (APPM) Forests manage 107 000 hectares, including 80 000 hectares of freehold land in one consolidated area of resource base in Tasmania. They also have management responsibility for a Forest Concession drawn up in 1926, of non-allocated Crown land which by agreement is jointly managed by APPM and the Forest Commission. The company has 12 000 hectares of softwood plantation and 21 000 hectares of eucalypt plantation (mainly *E.nitens*, 18 000 hectares). A predicted market demand for hardwood chip fibre is resulting in the softwoods being gradually replaced by eucalypts with an annual planting program of 2 400 hectares per annum.

An average rainfall of between 800 millimetres at Burnie to 1 800 millimetres in high altitude forests and a history of only five hectares of fire affected plantation in 10 years suggests that fire is not a big issue for APPM. Despite this the company recognises the potential for fire damage of valuable assets and implements basic fire control measures. Although not legislated the company maintains a standard firebreak width of five metres around softwood plantations to meet insurance requirements. Compartment size is typically 50 to 60 hectares.

Fire detection is provided by lookout tower and an aircraft, shared on a 50-50 cost basis with the Forestry Commission, is used during periods of high danger, with the frequency of flying and circuit determined by the hazard of the day.

As a result of climatic conditions native forests adjoining plantations do not regularly dry out sufficiently to enable fuel reduction burning of them to be carried out. They do inevitably increase in fuel loadings and become sufficiently dry enough to carry a wildfire during extended dry periods. To achieve a level of protection of plantations in this environment APPM carry out fuel reduction of the more readily available native grasses such as white grass and button grass.

CONCLUSIONS

Liaison

Running fires do not recognise land tenure or purpose boundaries. It is essential that organisations likely to be involved in fire suppression liaise closely in the early stages of fire pre-suppression planning to initiate complimentary fire protection mechanisms, whether they be lookout tower, roading or fuel management. Liaison serves to provide coordinated approach to planning and facilitates a cooperative, pre-determined process for wildfire suppression.

An integrated land management agency such as CALM would appear to have some advantages when attempting to resolve fire management issues on public land without duplicating resources and effort.

Legislated Standards

Western Australia was the only State to have in place legislated minimum plantation fire protection standards, through local authorities firebreak order. While acknowledging that there remains some variation in standards in Western Australia there is a general acceptance of the principle. Throughout the Eastern States only few local authorities chose to stipulate any minimum standards for plantations. There would seem to be a place for minimum fire protection standards which do not compromise fire protection or commercial viability and are acceptable to the community and industry.

Detection

Early detection of any fires threatening plantations is essential and can be performed by aircraft, fire lookout tower, ground patrols, neighbour watch, general public or other higher levels of technology if finance is unlimited.

Notable in the Eastern States was the almost exclusive use of lookout towers, often supplemented with aircraft on high danger days or during wildfires, to provide a means of detection. Use of aircraft as the primary means of locating fires was restricted to West Australian operations. The increasing costs of operating an aerial detection system dictate that a comparative assessment be made of the benefits, compared with the use of towers.

Plantation Management

- i) Location - Most organisations have guidelines as to the preferred location of plantations in relation to suppression forces, road access, airstrips or fire history. In reality many plantations are in their present location due to either the unsuitability of the land for other agricultural pursuits or as the result of employment or rehabilitation schemes. Interestingly, parts of plantations in New South Wales and Victoria, which were on steep slopes and had been affected by fire were being allowed to regenerate to native forest and not being replanted to plantations.
- ii) Design - As with plantation location, many managers have inherited the difficulties and fire control risks of historical plantation design. Examples were observed in South Australia and Victoria, where plantations, roading and firebreak patterns were being redesigned or modified at thinning to provide a more favourable design pattern. Most plantations were designed on a grid based upon either maximum harvesting machine distance or a relationship to the hose laying capacity of suppression crews. Plantations on slopes over 20 degrees were of necessity designed on the contour and dictated by grades suitable for haulage equipment.

Victorian DCE Fire Branch were advocating aligning new plantations north west - south east into the worst predicted fire run from the north west. Essentially this was an acknowledgement that direct attack on a headfire was not possible and the proposed alignment would facilitate a flank attack with minimum loss of plantation.

- iii) Fuel Reduction Burning - In almost all areas visited policies existed for fuel reduction burning of lands held by the managing authority to provide broad scale protection to plantations.

With the exception of the *P.taeda* and *P.elliottii* plantations in northern New South Wales, under pine burning was not conducted in any significant way to contribute to fire protection. This could be associated with the perceived and inherent risks, limited finance, narrow window of opportunity of optimum conditions and a lack of operational experience.

Fire was being used in Victoria to control wilding regrowth and reduce fuels along the plantation edge (Central Gippsland).

A general impression was gained that fuel reduction burning outside plantations had also declined and that in many cases implementation was left largely to local staff with differing interpretation as to the degree of importance fuel reduction burning had amongst other operational demands.

- iv) Fire Breaks - The interpretation of specifications for firebreaks around plantations remains variable.

Fire threat to plantations is most likely from external sources, hence breaks should be located where the fire fighting is the easiest and breaks are practical to maintain. Debate continues as to the effectiveness of firebreaks and the effect they have on local winds, however suffice to say they should be of a minimum width to operate a fire tanker, with turnarounds and at least five metres cleared to mineral earth. Vertical clearance must be maintained to ensure passage for fire vehicles.

It is quite clear that external firebreaks cannot stop a high intensity fire but provide an opportunity to do so in more mild conditions, facilitate access for fire control vehicles and a point from which to carry out burning operations.

- v) Pruning - The value of pruning for fire control operations has been debated for many years. Benefits from improved access both foot and vehicular, improved visibility and reduction of the fuel link between ground and crown fuel may be countered by increased wind speed in the stand. If pruning debris is left on the stand this serves to negate the gains achieved from low pruning by adding to the surface fuels.

From a fire control perspective, low pruning of edge trees and trees along compartment roads to maintain vertical clearance for access should be considered a minimum standard. More extensive pruning to create crown fire free zones is being practised in some areas and the implementation being considered in others, without any real concept of their effectiveness.

A Ph.D student, Martin Alexander is preparing a thesis on the threshold conditions for the initiation and spread of crown fires in exotic pine plantations. His thesis may provide useful data on the value of extensive or strategic pruning from a fire control perspective.

- vi) Thinning - Timing, Location - In addition to providing a market product; thinning of a plantation opens the stand up improving access, visibility for fire control, increasing the opportunities for under pine burning and increasing the potential of a stand to reduce the progress of a fire. The benefits are more marked where either the action of mechanical harvesting or post harvest treatment has modified the arrangement of the thinning debris.

Examples were observed where delayed thinning had contributed to an unfavourable fire history. Fire management staff need to have an active input into harvesting plans to minimise the potential for disastrous fires.

It would be unreasonable to attempt to make firm conclusions as to the methods of providing protection from fire to exotic plantations based on the observations of the study tour. A more detailed assessment of the threats and risk of fire to plantations in any given area and of the effectiveness of any fire protection measures in place when an actual fire was experienced would need to be made. There is no doubt, however, that there is no replacement for an awareness of fire protection requirements, application of basic principles and for early detection and rapid response to any fire which may threaten an exotic plantation.

Western Australia would seem to be well placed in the level of awareness, management and application of fire management principles in plantations.

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NOTE: The reference documents, supporting notes and a comprehensive set of colour transparencies relating to this report are held by the Author.